United States Department of Agriculture	Forest Service	Wallowa-Whitman National Forest	La Grande Ranger District 3502 Highway 30 La Grande, OR 97850

File: 2550 Soil Management **Date:** July 25, 2015

Subject: East Face Vegetation Management Project
Soils Existing Condition and Effects Analysis

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Introduction

The following is a summary of the existing condition of soils within the 47,621 acre East Face Vegetation Management Project (hereafter referred to as East Face).

Implementation standards and guidelines from the Wallowa-Whitman National Forest Land and Resource Managment Plan (LRMP) as amended, including the PACFISH amendment for grazing management and the Wallowa-Whitman National Forest Watershed Management Practices Guide for Achieving Soil and Water Objectives (WMPG) and the 2012 National Best Management Practices fore Water Quality Management on National Forest Service Lands will be considered during the formulation of action alternatives for this project.

Analysis Framework: Statute, Regulatory Environment, Forest Plan and Other Direction

Regulatory Environment

The regulatory framework providing direction for protecting a site's inherent capacity to grow vegetation comes from the following principle sources:

- *Organic Administration Act of 1897*
- *Bankhead-Jones Act of 1937*
- *Multiple Use-Sustained Yield Act of 1960*
- *National Forest Management Act of 1976 (NFMA)*
- *FSM 2500 – Chapter 2550 – Soil Management*
- *Forest Plan and Regional Soil Quality standards (R6 SUPPLEMENT 2500-98-1)*

The Organic Administration Act of 1897 (16 U.S.C. 473-475) authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests and "…to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

The Bankhead-Jones Act of 1937 authorizes and directs a program of land conservation and land utilization, in order thereby to correct maladjustments in land use, and thus assist in controlling soil erosion, preserving natural resources, mitigating floods, conserving surface and subsurface moisture, protecting the watersheds of navigable streams, and protecting the public lands, health, safety, and welfare.

The Multiple Use-Sustained Yield Act of 1960 directs the Forest Service to achieve and maintain outputs of various renewable resources in perpetuity without permanent impairment of the land's productivity.

The National Forest Management Act of 1976 (NFMA) charges the Secretary of Agriculture with ensuring research and continuous monitoring of each management system to safeguard the land's productivity. To comply with NFMA, the Chief of the Forest Service has charged each Forest Service Region with developing soil quality standards for detecting soil disturbance and indicating a loss in long-term productive potential. These standards are built into Forest Plans.

The FSM 2500 Chapter 2550 Soil Management directive establishes the framework for sustaining soil quality and hydrologic function while providing goods and services outlined in forest and grassland land management plans.

Forest Plan

The Forest Plan specifies a general goal of maintaining and enhancing soil productivity (LRMP 4-21), with specific Standards and Guidelines as follows:

1. **Conflicts with Other Uses.** Give maintenance of soil productivity and stability priority over uses described or implied in all other management direction, standards, or guidelines. Exceptions may occur for such things as campgrounds or transportation facilities when it is determined, through environmental analysis, to be in the public interest. (LRMP 4-21)
2. **Protection.** Minimize detrimental soil conditions with total acreage detrimentally impacted not to exceed 20 percent of the total acreage within the activity area including landings and system roads. Where detrimental conditions affect 20 percent of more of the activity area, restoration treatments will be considered. Detrimental soil conditions include compaction, puddling, displacement and severe burning. (LRMP 4-21)
3. Give special consideration to scablands or other lands having shallow soils during project analysis. Such analysis will especially consider the fragile nature of the soils involved and, as necessary, provide protection and other mitigation measures. (LRMP 4-21)
4. Use approved skid trails, logging over snow or frozen ground, or some equivalent system for limiting the impact and areal extent of skid trails and landing and to prevent cumulative increases from multiple entries in tractor logging areas. (LRMP 4-21)
5. Re-establish vegetation following wild fire or management activities where necessary to prevent excessive erosion. (LRMP 4-21)

The Forest Service Region 6 soil quality standard recommends maintaining soil at an acceptable productivity potential in no less than 80% of an activity unit area. Impaired productivity potential is evaluated as detrimental impacts, including the effects of compaction, displacement, rutting, severe burning, surface erosion, loss of surface organic matter, and soil mass movement. Maintenance of sufficient surface detritus (fine and coarse woody material) is stated as essential for soil productivity.

Existing Conditions

The dominant soils in the East Face project area developed over layers of volcanic derived basalt, andesite and volcanic breccia's, collectively described as Columbia River basalts. These basalt and andesite colluvium derived soils, the most typical within the Blue and Ochoco Mountains (Johnson and Clausnitzer, 1992) are represented in the northern portions of the project area. Within the southern portion of the project area, granitic soils are found. This granitic intrusion, the Anthony Lake Granodiorite Formation (Taubeneck 1957) of the Bald Mountain Batholith, is most noticeable in the Anthony Lakes recreation area. This mass of granitic rock extends for over 144 square miles (Orr et al. 1992). The resultant decomposed granitic soils on the southern portion of the East Face project are found within many of the proposed treatment units south of Wolf Creek.

The arrangement of these soils vary greatly and may range from those on thin, rocky, low-productivity ridgetop scablands to those in deep ash accumulations on very productive grand fir sites.

In the majority of the area the soil is buried under a mantle or cap of volcanic ash deposited from the eruption of Glacier Peak (12,000 years ago) and Mount Mazama (6600 years ago).

Soils with a high amount of ash in surface horizons are common in the project area, ranging from relatively thick to non-existent. Ash-cap soils derived from volcanic eruptions are most often classified in the silt or sandy loam categories. They are also characterized by low bulk density, high porosity, and high water holding capacity. They tend to be non-cohesive and because of their relatively low strength, are highly susceptible to compaction (Johnson, Page-Dumroese and Han 2007). Ash-cap soils can be susceptible to disturbance during forest management, and strategies to predict compaction, displacement and erosion hazards are essential for planning forest management operations (Curran, Green and Maynard 2007). Soil depth, combined with the depth of the unconsolidated material lying over bedrock in the project area ranges from very shallow (less than 10 inches) to deep (40-60 inches). The surface soil layer is the layer that supports the root zone for fine and medium size roots.

Soils with an ash mantle commonly have a different surface texture than the material buried beneath the ash. Typically, soil textures in the project area are silt loams with varying rock content. Subsurface layers in the project area are generally rockier than surface layers. In general, soils consist of basalt or andesite parent material with a volcanic ash-cap over colluvium and residuum.

Soils information for this analysis was obtained and interpreted through data collected by the NRCS Soil Data Mart website and the WWNF Ecological Unit Inventory (EUI). The EUI, which meets the standards of the National Cooperative Soil Survey, describes soil map units, their individual components, and provides interpretive information on soil use and management.

Soil Description

In the East Face project area, soils within the treatment units occur within several Land Type Associations (LTAs). LTAs are a product of the interaction between soils, geology, landforms, vegetation and climate. For this project, soils are described in relationship to the LTAs where they occur (**Table 1**).

Table 1. East Face Project Land type Association (LTA) description.

LTA	Geology Group	Landform	Project area Acres (47,621)	Percent of project area
116	Basic Igneous Rocks	Mountain Slopes, Gentle	14,670	32%
117	Basic Igneous Rocks	Mountain Slopes, Steep	3,013	6%
126	Clay Producing materials	Mountain Slopes, Gentle	996	2%
131	Glacial-Undifferentiated	Trough Floors	3,263	7%
132	Glacial-Undifferentiated	Trough Walls, Cirques, & Alpine Ridges	3,056	7%
156	Acid Igneous Rocks-	Mountain Slopes, Gentle	10,583	23%
157	Acid Igneous Rocks-	Mountain Slopes, Steep	4,833	10%
167	Exotic Terrane Rocks- Seafloor	Mountain Slopes, Steep	5,693	12%
231	Glacial-Undifferentiated	Trough Floors	183	<1%
Unknown			159	<1%

The number of acres of landtypes indicated in the table above is not exact, but has been condensed and rounded to indicate relative amounts of major landtypes. Also, the LTAs in the project area are complexes and are made up of several soil series further described as map unit symbols (MUS). The major soil series were used to determine the soil properties of the LTA and the minor and other soil series were considered but not used individually.

The following is a description of the LTAs in the East Face Project area:

Landtype 116

This LTA consists of volcanic ash over colluvium and residuum derived from basalt or andesitic tuff breccia. Soils occur on gentle mountain slopes 15% and greater and plateaus, supporting moist forests. This LTA covers 5,609 acres of treatment units or 34% of the treatment area. The dominant map unit symbol (MUS) for this LTA within treatment units is 5776CN.

Major Soil Series	Soil Depth	Surface (0-10")				
		Surface Texture	Kw factor	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Limberjim	40-60"	Ashy silt loam	0.43 Highly Erodible	0.75 High Compaction	Well	Moderate

Landtype 117

This LTA consists of volcanic ash mixed with loess and colluvium in surface horizons over colluvium derived from basalt. Soils occur on steep mountain slopes 30% and greater and plateaus, supporting moist forests. This LTA covers 1,265 acres of treatment units or 8% of the treatment area. The dominant MUS for this LTA within treatment units is 5834CO.

Major Soil Series	Soil Depth	Surface (0-10”)				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Klicker	10-20”	Gravely Silt loam	0.28 Moderately Erodible	0.75-1.25 High to Moderate Compaction	Well	Moderate-Severe

<u>Landtype 126</u>

This LTA consists of volcanic ash and loess over colluvium and/or residuum weathered from acidic tuff. Soils occur mountain slopes less than 30% and plateaus, supporting moist forests. This LTA covers 278 acres of treatment units or 2% of the treatment area. The dominant MUS for this LTA within treatment units is 5775BO and 3311BO.

Major Soil Series	Soil Depth	Surface (0-10”)				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Syrupcreek	20-60”	Ashy silt loam	**0.55** Highly Erodible	0.75 High Compaction	Well	Moderate
Bler	20-40”	Ashy silt loam	**0.55** Highly Erodible	0.75-1.41 High to Low Compaction	Well	Moderate-Severe

<u>Landtype 131</u>

This LTA consists of volcanic ash over till derived from granite. Soils occur on glacial valley floors 15-30% and supports moist forests. This LTA covers 1,137acres of treatment units or 7% of the treatment area. The dominant MUS for this LTA within treatment units is 9413BO and 0815CS.

Major Soil Series	Soil Depth	Surface (0-10”)				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Mudlakebasin	20-40”	Ashy silt loam	**0.55** Highly Erodible	0.82	Well	Moderate
Muddycreek	Greater than 60”	Extremely stony ashy sandy loam	**0.43** Highly Erodible	1.15 Low Compaction	Well	Severe

<u>Landtype 132</u>

This LTA consists of volcanic ash over till derived from granite. Soils occur on glacial valley floors, cirque basins and mountain slopes 15-60% and supports moist forests. This LTA covers 797 acres of treatment units or 5% of the treatment area. The dominant MUS for this LTA within treatment units is 9413BO.

Major Soil Series	Soil Depth	Surface (0-10")				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Mudlakebasin	20-40"	Ashy silt loam	**0.55** Highly Erodible	0.75-0.82 High Compaction	Well	Moderate-Very Severe

Landtype 156

This LTA consists of volcanic ash over residuum weathered from granite. Soils occur on gentle mountain slopes 15-30% and supports moist forests. This LTA covers 3,585 acres of treatment units or 22% of the treatment area. The dominant MUS for this LTA within treatment units is 0917BN.

Major Soil Series	Soil Depth	Surface (0-10")				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Prouty	20-40	Gravely ashy loam	.17 Low Erodibility	0.78 High Compaction	Well	Moderate

Landtype 157

This LTA consists of volcanic ash over residuum weathered from granite. Soils occur on steep mountain slopes 15-30% and supports cold forests. This LTA covers 1,715 acres of treatment units or 11% of the treatment area. The dominant MUS for this LTA within treatment units is 0903CS.

Major Soil Series	Soil Depth	Surface (0-10")				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Warfield	40-60"	Gravely ashy sandy loam	.24 Moderate Erodibility	0.82-1.03 High to Moderate Compaction	Well	Severe-Very Severe

Landtype 167

This LTA consists of volcanic ash over residuum weathered from granite. Soils occur on mountain slopes 15-60% and supports moist forests. This LTA covers 1,875 acres of treatment units or 11% of the treatment area. The dominant MUS for this LTA within treatment units is 7714DS (25%) and 7717CN (23%).

Major Soil Series	Soil Depth	Surface (0-10")				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Analulu	20-40"	Very gravelly loam	.15 Low Erodibility	0.91-1.03 Moderate Compaction	Well	Moderate-Very Severe
Gutridge	40-60"	Gravelly ashy silt loam	.32 Moderate Erodibility	0.75-0.85 High Compaction	Well	Moderate-Severe

Landtype 231

This LTA consists of volcanic ash over drift derived from granite. Soils occur on mountain slopes 0-30% and supports dry forests. This LTA covers 122 acres of treatment units or 0.75% of the treatment area. The dominant MUS for this LTA within treatment units is 0858NO (65%).

Major Soil Series	Soil Depth	Surface (0-10")				
		Surface Texture	Kw factor Soil Erodibility	1/3 bar Bulk Density	Drainage Class	Erosion Hazard Rating Un-vegetated
Bata	Greater than 60	Gravely ashy silt loam	.20 Moderate Erodibility	0.82-1.03 High to Moderate Compaction	Well	Moderate-Severe

Soil erosion is a natural process that can be accelerated by land management activities; it depends on soil texture, rock content, vegetative cover and slope. Ash soils have higher soil erosion hazard ratings than other soils because of their low bulk density and high detachability. This can be ameliorated by operating on slopes less than 30% with good vegetative cover. Vegetation binds soil particles together with roots, and vegetative cover – including biological crust and duff/surface material – protects the soil surface from raindrop impact and dissipates the energy of overland flow.

Individual soils found within the East Face project area along with soil properties of erodibility (Kw factor) and compaction potential (bulk density) were assessed from data available from the NRCS Soil Data Mart website. Surface soils within the project area range from 0 inches at rock outcrops to greater than 60 inches deep.

Individual soils are grouped together to create "map units" or "soil complexes" which retain the properties of each individual soil. Each map unit has a name and an assigned map unit symbol (MUS) consisting of numbers and letters. **Appendix A** displays the acres of each soil complex by MUS that occurs across all East Face treatment units. The dominant map unit and corresponding analyzed compaction potential and erosion hazard for each harvest unit which includes mechanical treatment is also listed in **Appendix A**.

Most of the dominant soil complexes are derived from ash mantle cover or ashy silt loams and have a high inherent compaction potential. Compaction potential increases when rock fragments within the soil decreases and ash component increases.

Soil with bulk densities greater than 1.0g/cc generally indicate a lower compaction potential. These soils contain higher percentages of rock fragments which increases bulk density and reduces potential erodibility. Soils with bulk densities less than 1.0g/cc indicate a higher compaction potential due to higher porosity, weaker structural development, lower cohesion and lower coarse fragment (>2mm) content (Craig and Howes, 2005).

0.65-0.85g/cc= Low BD= High compaction potential
0.85-1.1g/cc= Moderate BD= Moderate compaction potential
1.1-1.4g/cc= High BD= Low compaction potential

Most treatment units were identified as having between 0.65-0.85g/cc bulk density at 1/3 bar pressure for the dominant MUS, indicating high compaction potential.

The inherent erodibility of soils is calculated in a laboratory in the absence of live vegetation or effective ground cover and is based on soil texture and detachability, not slope gradient. Most treatment units were identified as having moderate to very severe erosion hazard without vegetation. With the addition of live vegetation and associated root mass or organic duff layer, the surface erosion potential due to overland flow is greatly reduced.

This erodibility is also described as the K factor. The Kw factor = the actual erodibility of the soil profile and is based on all inorganic components of the soil.

Kw factor = 0.05-0.2 is low erodibility
Kw factor = 0.2-0.4 is moderately erodible
Kw factor > 0.4 is highly erodible

Soil Productivity

Soil productivity of a site is defined as the ability of a geographic area to produce vegetative biomass, as determined by abiotic conditions (e.g. soil type and depth, rainfall and temperature) in that area. Specifically as related to soils in this analysis, productivity is related to the capacity or suitability of a soil for establishment and growth of appropriate plant species, primarily through physical impediment to root growth, water availability, and nutrient availability.

Productivity of forested and non-forested plant communities is closely related to ash and loess content in soils. Unique characteristics of ash soils include: 1) high water holding capacity, 2) high water infiltration rates, 3) low compatibility, 4) high detachability and 5) disproportionately high amounts of nutrients in upper surface layers. Under undisturbed conditions, these soils support good vegetation cover which protects the ash from erosion (USDA, 1985).

The productivity of forest soils can be adversely affected by removal of nutrients and alterations in the soil structure. Removal of nutrients can occur through the removal of vegetation (i.e. trees, shrubs and grasses), erosion, preparation of sites for treatment and burning. The effects of soil disturbance on soil productivity and the duration of adverse effects largely depend upon the type of disturbance. Disturbances such as roads and ditches generally are long term because the soil structure is severely altered during construction. Compaction from tractor yarding can potentially last for several decades (Froehlich and McNabb 1984), thereby reducing productivity. Soil surface erosion rates following timber harvest can potentially remain elevated for several years, depending upon the yarding method (Johnson et al. 2007). The effects of nutrient removal through woody debris removal, erosion, burning and site preparation can be short lived, or long lasting depending upon the extent, duration and intensity of the disturbance (Harvey et al. 1994).

<u>Sheet and Rill Erosion</u>

Soil erodibility is a function of cohesion, infiltration rate, and permeability of lower horizons, uniformity of slope and slope percent, water concentration potential, distribution of annual precipitation, rainfall intensities, soil temperatures, and the density of effective ground cover before and following disturbance. Soil erosion is a natural process that can be accelerated by land management activities. Soils on steep slopes with poor vegetative cover and lack of structural development are more susceptible to erosion than are soils on flatter terrain. Vegetation protects the soil surface from raindrop impact, dissipates the energy of overland flow, and binds soil particles together.

<u>Gully and Landslide Erosion</u>

The project area is generally a stable landscape and the potential for landslides to occur is relatively low with some moderate potential on steeper slopes. When vegetated, the soils and geology in the project area are not prone to mass movement. There are prehistoric landslides within the East Face project area (Oregon Department of Geology) but none are known to be currently active.

Soil Compaction and Displacement

In the East Face project area soil compaction is a primary disturbance factor affecting soil productivity. Skid trails, landings and non-surfaced roads, ATV trails and dispersed campsites all have led to increased soil compaction and bulk density throughout the project area.

Soil displacement is the movement of soil from one place to another by mechanical forces and is typically associated with roads, landings, and skid trails. Effects include reduced water holding capacity, loss of ground cover, nutrients and soil microorganisms, and increased runoff due to an increased amount and condition of bare ground exposed (Page-Dumroese et al 2007.

Detrimental Soil Conditions

The Forest Plan defines detrimental soil condition as any management practice that results in soil compaction, puddling, displacement, erosion, mass wasting, or severe burning. Soil damage can negatively affect the productivity of a site. Generally speaking vegetative, forest floor, and soil process appear to be functioning properly in the majority of the project area. Residual soil disturbance is limited due to the topography and the ability of the soil and vegetation to recover following disturbance in this area.

The majority of soil compaction occurs on the existing system haul roads, which are relatively abundant due to past harvest activities in the project area.

Soil displacement is defined as the movement of soil from one place to another by mechanical forces such as a wheel, blade or animal hoof. Evidence of surface soil displacement by mechanical disturbance is relatively limited within the East Face project area however areas with user created roads are frequent.

The majority of soil displacement occurs on the existing system haul roads, which are relatively abundant due to past harvest activities in the project area.

The total existing percent detrimental soil conditions (DSCs) in each potential mechanical unit within the East Face project is displayed in **Appendix B**. Existing detrimental soil conditions (DSCs) were determined for each unit within the East Face project area. DSCs within the units in the project area range from a low of 0% to a high of 14% with an average across the planning area of approximately 4%. This estimate was calculated based on an assessment or estimation of the existing DSCs within the unit boundaries and then re-calculated to include DSCs attributable to the existing roads within or adjacent to each unit.

Existing road acreage for roads totally within a unit was reached by multiplying the miles (converted to feet) of road by an average of 20 ft. width and dividing by 43,560. Existing road acreage for roads adjacent to a unit was calculated using a 12 ft. width.

An estimated 1% percent DSCs was used for each treatment unit not inventoried based on the expected level of DSCs for similar units with similar past harvest activities the project area.

EFFECTS ANALYSIS

Introduction

The following displays the effects on soil resources for the proposed 47,621 acre East Face project. Specific effects to soil resources are further detailed to the treatment unit as necessary to provide site specificity. Treatment units are used for analysis since these are the areas where measurable effects to soil resources occur, including cumulative effects. Unit of measure is typically by the acre, a percentage of the unit in question and miles of road.

Assumptions

Effects to soils can be short-lived (one to three years) in the case of erosion potential; soil erosion potential depends on soil type and vegetative cover to determine how long risk of erosion is a concern. Erosion control measures normally occur immediately following treatments and / or re-vegetation occurs in the first year or two. Other effects to soils such as compaction, rutting, and displacement tend to be longer term impacts that are cumulative in nature if these types of impacts have not fully recovered when new activity occurs in the same location.

Management activities can result in direct, indirect and cumulative effects on soil productivity and soil stability (USFS 1998). Effects may be beneficial or adverse. Effects may include alteration of physical, chemical, and / or biological characteristics or properties of soils. Many standards and guidelines in the Forest Plan, in addition to the five identified specifically in the soils section, relate to soil function, soil productivity and soil stability.

The most adverse effects of management activities on soils are described as detrimental compaction, detrimental puddling, detrimental displacement, detrimental burning, detrimental erosion, and detrimental mass wasting; other concerns include adverse changes in vegetation and organic matter on the soil surface, and adverse changes in water table (USFS 1998). Soil compaction, puddling, displacement, severe burning, and impacts to ground cover (vegetation and organic matter) are direct effects; soil erosion, mass wasting, and changes in water table are indirect effects. Cumulative effects are the sum of incremental changes in past, present, and reasonably foreseeable future direct / indirect effects on the soil resource that overlap both in time and space. Recent past, ongoing, and foreseeable future effects are captured in **Appendix D** of the East Face project analysis document.

The magnitude of the effects of an activity on soil function, soil productivity and soil stability are described by the speed, direction (upward / downward), extent, and duration of change. Minimizing productivity losses associated with any action can be accomplished by managing the magnitude of detrimental soil conditions (DSCs) within activity areas through prescription and/or mitigation. DSCs are to be minimized, with total acreage detrimentally impacted not to exceed 20 percent of the total acreage in the project area including landings and system roads. The project area is identified as each treatment unit for determining DSCs prior to treatment (WW interim protocol 2002). Post treatment restoration is necessary for areas that exceed this standard and guide. (LRMP 4-21).

Planned management activities must minimize new soil damage and must provide for restoration measures when and where they are appropriate (WWNF 1990, Soils S&Gs).

Cumulative effects are rated as negligible, minor, moderate or major based on professional judgment. Negligible means the effect of an activity on an indicator was so small it was not measurable, or caused a change of less than 1%, or less than 1% of an area was affected. Minor means the effect was a change equal to less than one-half of the flexibility for a standard, or 1-10% of an area was affected. Moderate means the effect was a change equal to more than one-half of the flexibility for a standard, or 11-20% of an area was affected. Major means a standard was exceeded or more than 20% of an area or resource was affected; e.g. the detrimental soil condition threshold is 20% (USFS 1998).

<u>Ground Based Logging Model</u>

Utilizing modern harvest equipment and technique, the East Face Project design will utilize skid trails an average of 60-75 feet apart on tractor ground (35% and less slope). This spacing will accommodate forwarder or whole tree removal systems. Bliss et.al, 2006, determined that at this spacing, new ground based yarding activities would disturb about 10-20% of the ground surface dependent upon type of equipment used **(Table 2).**

Equipment choice will either increase or decrease potential accrual of DSC's. Full suspension removal equipment would be in the lower estimation of DSC as the logs are not displacing soil between the wheel tracks. Partial suspension (grapple) results in moderate displacement of soil between wheel tracks whereas non suspension or cable skidding results in displacement of the entire width of the skid trail.

Past monitoring has shown that 50% of skid trail width is detrimentally compacted and displaced, resulting in approximately 8-10% DSCs per unit before implementation of mitigations (Bliss, WWNF, 2006). Landings would occupy about 1-2% of a unit. The effect of skid trails plus landings would be about 10-12% new DSCs before subsoiling in those units where there no pre-existing conditions (DSCs) occur. Subsoiling as mitigation can be prescribed for those units where DSCs would potentially exceed LRMP standards.

Table 2. Skid trail spacing and associated potential cumulative DSC's

Elements	Spacing/Width/Potential DSC			
Skid Trail Spacing	60'	75'	80'	100'
Skid Trail width	12'	12'	12'	12'
Potential surface disturbance	20%	16%	15%	12%
Expected DSC- 50% of total surface disturbance by treatment unit	10-12%	8-10%	7-9%	6-8%

As noted in the soils existing condition section, ground transects of older tractor logging impacts in the project area indicate that low levels of DSCs (average of 1-2%). Many areas showed little to no visible skid trails remaining, precluding the reuse of these past tracks. There was little disturbance (less than or equal to 1%) in units where selective harvest did not produce multiple skid trails. This would suggest that the level of DSCs within the project area would not measurably increase post-harvest using similar logging techniques and mitigations.

Using the results of this survey, 10-20% new ground surface disturbance would be equivalent to an average range of 6-12% potential DSCs (including 1-2% landing disturbance) in those units where no past entry had occurred. Several factors would influence actual effects of new activity, such as equipment type, operator skill, coarse woody debris and slope gradient; use of existing skid trail network and landings; and soil moisture, rockiness and density. With 60-foot skid trail spacing on volcanic ash soils, potential DSCs could be in the upper half of the 6-12% DSC range, or about 10-12% DSCs. For this analysis, 10% new DSCs will be used for analyzing tractor units with no past entry and 8% new DSCs for any unit with past tractor entry. It is expected that some past harvest unit skid trails may be reused, thereby reducing the potential accrual of new DSCs.

Soil effects resulting from the use of a forwarder instead of a tractor would similar however forwarder based removal systems generally result in slightly lower accumulation of DSC's (Bliss, WWNF, 2003). This project does not differentiate between tractor or forwarder based harvest and has used tractor based logging as the baseline for effects analysis of potential DSCs. The exception to this estimate is where soils were rated severe or very severe for erosion without vegetation.   Cut to length harvest where the tops and limbs are left onsite and forwarders used for removal is required for these units to allow retention of biomass to reduce surface erosion following log removal. This mitigation is expected to reduce accumulation of new DSC's to 8%. Biomass removal as proposed in Alternative 5 is expected to have similar effects as forwarder removal and will be estimated as such.

Roads Effects Model

Road effects can be modeled for two slope positions: gently sloping ridges and benches, and moderately steep side slopes. Roads on ridges and benches would be about 12-14 feet wide, with an average disturbed area of 1.6 acres per mile. Roads on side slopes would be 20-30 feet wide, with an average disturbed area of 3 acres per mile. This is equivalent to a 25 foot wide roadway, top of cut to bottom of fill. The entire disturbed area will be treated as a DSC. (Derived from Bliss, WWNF 2006)

For this analysis an average of 20 feet was used to determine DSC's across the project.

Temporary Road Effects Model

Temporary road effects are expected to be the same as permanent roads unless mitigations are implemented. A reduction of 80-90% of the accumulated DSCs can be expected with re-contouring. Total residual DSC's would remain at 10-20% due to mixing of the soil and because re-contouring does not exactly recreate the pre-road slope shape and soil depth (derived from Bliss, WWNF 2006).

For this analysis an average of 12 feet was used to display DSC's across the project. Residual accumulated DSC's would be 20% of total area affected following mitigation of recontouring.

Underburn Effects Model

Burn effects are based on definitions in (DeBano et. al 1998) and (USFS 1998). Underburn effects qualify as detrimental soil conditions if they are severe burns and occupy an area of at least 100 square feet (USFS 1998). Local data (Bliss 2003a) indicates there would be 0-4% severe burn effects in prescribed fire underburn areas, but no DSCs because severe burn areas would be less than 100 square feet. Severe burn effects typically occur adjacent to and under logs and in burned out stump holes. Underburn effects may range from low-severity burn class to high-severity burn class, based on percent moderate fire severity, but do not qualify as detrimental soil conditions.

Grapple Pile Effects Model

Effects are based on definitions of detrimental compaction and displacement (USFS 1998). The equipment to be used for grapple piling of woody debris would be a low ground pressure tracked vehicle with a grapple. Normal use would track a maximum of 8% of a treatment unit. Total ground disturbance would be 5-8% with an estimate of 2% DSCs. Actual DSCs would be affected by variables such as soil density, percent rock in/on the soil surface greater than 3 inch diameter, soil moisture (veg type and woody debris tonnage) type of equipment used and operator skill.

Slashbuster treatment would have similar disturbances (Naughton pers comm.) although the material following treatment would remain on site and reduce potential compaction and displacement, estimate 2% DSCs.

Project Mitigations

The mitigating measures listed below will be implemented to meet the standards and guidelines in the Wallowa-Whitman LRMP. Best management practices (BMPs) are forest management practices designed to prevent the degradation of forest lands and water quality during and after timber harvest. Forestry BMPs have been shown to be effective at controlling sediment, erosion, and nutrients from forest management activities (Lynch and Corbett 1990; Stuart and Edwards 2006). **Table 3** describes unit specific mitigations for individual units. These mitigations are expected to reduce accumulated DSC's due to compaction and displacement on soils with low bulk densities or units where accumulated DSC's exceed 20% within the project unit.

Mitigations include:

- Use of lower ground pressure forwarders to decrease accumulated DSC's due to compaction and displacement or subsoiling return skid trails and or landings to reduce compaction**. Trigger: Units where soil bulk densities are low (<0.85) and potential for compaction is high.**
- Use of mastication for fuels treatment instead of grapple piling to reduce soil displacement and retain vegetative biomass for soil protection and productivity. **Trigger: Units where estimated DSC's are 15% or more.**
- Use of hand piling instead of mechanical treatment to reduce accumulated DSC's due to machine fuels treatment displacement and machine pile burning. **Trigger: Units where estimated DSC's may exceed 20% if machine fuels treatment/burning are prescribed.**

Table 3 –Unit Specific Soils Mitigations

Mitigation	Affected Units
1. Cut to Length (Forwarder) or subsoil return trails required. High Compaction and erodibility potential of soils.	2,4,6,7,8,12-18,21,25,27,29-34,42-44,46-53,55-57,59-67,70-73,77,79,80, 82-86,91-95,97,98,104-106,110,114,115,117,119-121,123,125-129,131, 138,139,142,143,145-147,149,154,163-165
2. Mastication only – No grapple piling. To maintain soil cover following treatment and reduce expected displacement from grapple piling	7,10,11,12,14,17,24,26,29,33,35,56,58,69,71,77,78,80,82,87,91,103,111, 112,115,117,119,121,124,126,129,130,131,139,142,145,148,150,151,152, 153,154,156,157,159,162
3. Subsoil main skid trails and landings. To reduce accumulated compaction.	83,115,123,128
4. Hand piling only. To reduce expected displacement from mechanical fuels treatment and machine pile burning.	83,123,128

Region 6 Soil Quality standards and the WW LRMP require projects to:

> **Minimize detrimental soil conditions with total acreage impacted (compaction, puddling, displacement, and severe burning) not to exceed 20 percent of the total acreage within the project area (individual unit) including landings and system roads.**

The following guidelines from The Watershed Management Practices Guide for Achieving Soil and Water Objectives for the Wallowa-Whitman National Forest (Hauter and Harkenrider 1988) or more recent publications (Han 2005 and Flatten 2002) and are applicable to this project:

Skid trail spacing and location

Well placed, existing skid trails will be used as much as possible. Mechanical fuels treatment following harvest will use existing skid trails to access treatment areas (all mechanical fuels reduction units).

Soil Moisture

Limit equipment operations to dry (<15-20% soil moisture) (Han, 2005) or frozen/snow covered conditions (four inches of frost or a minimum of 12 inches of snow) (Flatten 2002).

Allowing skidding outside of these conditions increases compaction and puddling potential and makes mitigation by subsoiling/scarifying less effective. Operations outside of these conditions should be suspended both on and off trails.

Subsoiling and Scarification

Skid trails and landings will be evaluated for the need for subsoiling or scarification following treatment by the sale administrator and district watershed personnel to maintain site productivity based on soil depth and characteristics.

Units with high soil compaction potential **(see table 3)** where material is removed using tracked/rubber tires equipment versus forwarders will require subsoiling of return trails to reduce compaction and maintain soil productivity

Sufficient woody material will be left to maintain long term site productivity. This recommendation specifies a minimum of 10 tons per acre of woody material greater than 3 inches in diameter.

Where subsoiling is required, reclamation to improve soil productivity and reduce surface erosion will include:

1) Subsoil to a depth of 20-24 inches on multiple pass skid trails and all landings.

   Equipment to complete subsoiling may include:

   a) Use of a winged ripper with triggered tines to allow for more effective subsoiling in stony soil. Discontinue subsoiling where large rocks are continually brought to the soil surface, or operate with the shoes at a shallower depth (15 inches).

   b) Use of a tracked excavator with subsoiling tines.

2) Scattering of organic matter to provide a minimum of 50% effective ground cover.

3) Seeding with native seed to facilitate vegetation recovery

Where subsoiling is not required, reclamation to improve soil productivity and reduce surface erosion on all skid trails and landings will include:

1) Scattering of organic matter to provide a minimum of 50% effective ground cover.

2) Seeding with native seed to facilitate vegetation recovery

Water Bars-Erosion

Construct water bars on skid trails and mechanical firelines where soil disturbance is evident (and at the direction of the sale administrator and district watershed personnel), using the spacing guide below:

Gradient	Spacing
Under 20 %	80 ft.
20 - 39 %	40 ft.
Greater than 40 %	25 ft.

Construct waterbars on all temporary roads per standard gradient-related spacing guidelines (see Hauter & Harkenrider. WWNF, 1988, p. 47).

Construct waterbars on erosion-sensitive sections of roads, where pre-project erosion has and will continue to damage the road surface.

Seed roads, landings, and skid trails after logging is completed, as needed, with site-specific seed mix, for erosion control.

Monitoring

Best Management Practices (BMPs) and other methods for erosion control such as water bars, limiting operating seasons, designated skid trails, or the use of existing landings and designated skid trails, etc. are effective measures for minimizing or rehabilitating potential soil impacts. The analysis of effects included implementation of these mitigations to help reduce soil erosion and other effects, and help maintain DSC levels within Forest Plan standards for all action alternatives. Effectiveness monitoring of BMPs will take place during and after project activities for a percentage of units. Monitoring will occur on 10% of the East Face activity units to ensure DSC levels remain below Forest Plan minimums for the affected area.

BMP implementation monitoring which is evaluation of whether BMPs are used during the project will also take place. This monitoring will be carried out by the timber sale administrator, or by the district soils specialist.

Methodology

The above models were used in analyzing potential detrimental soil compaction conditions from project activities.

Post-harvest monitoring will be completed on ten percent of the mechanical units to ensure that project design and mitigations are properly implemented to ensure DSC levels remain below Forest Plan minimums.

For ground based removal, methods such as operating seasons, use of existing landings and skid trails, subsoiling, seeding skid trails, etc. are effective measures for minimizing or rehabilitating potential soil impacts. Utilizing these methods is expected to maintain DSC levels well within Forest Plan standards and guidelines for the proposed action.

In the following discussion, the degree of impact, of compaction, puddling, displacement, severe burning, erosion, mass wasting, organic matter loss and drainage class change is severe enough to classify effects as DSCs. Extent is described generally as affected area and duration is noted as years. The effects outlined below are based on soil mitigation measures being implemented in full.

The following activities associated with the East Face project are to be considered during the effects analysis by each resource area.

1. Commercial timber harvest (HFU,HTH, HIM, HPO, HSH, HSA) include logging systems (tractor, skyline, helicopter)
2. Non-commercial timber harvest (FFU) include removal method
3. Post-harvest treatments (grapple piling, slash-busting, hand piling, whipfelling, burning (prescribed and site prep), pre-commercial thinning, planting)
4. Pre-commercial Thinning w/o harvest
5. Non-commercial fuel reduction work mechanical (WFM) and by hand (WFH)
6. Biomass Removal
7. Prescribed Fire – including mechanical pre-treat
8. Mechanical Control lines for burning
9. Hand treatments within RHCAs
10. OFMS restoration to OFSS
11. Connective Corridors

12. Snag Retention
13. Temporary Road Construction (on existing wheel tracks and not)
14. Closed Roads Re-opened for Administrative Access (and reconstruction work to open)
15. Road Decommissioning
16. Roadside Hazard Tree Removal
17. Mitigation Measures
18. Whitebark Pine treatments
19. Treating in MA15
20. Treating in MA6
21. Bridge Replacement
22. Culvert Replacement

Direct and Indirect Effects on Soil Quality

ALTERNATIVE 1- No Action

This is the no action alternative, which means that all actions authorized by current management plans, permits, easements, and contracts would continue. Authorized actions on National Forest lands in the project area include agency actions, such as road maintenance and noxious weed treatments, and public actions such as fuel-wood removal, mining, and various types of recreation.

All current detrimental soil conditions would continue to exist, with some conditions improving, others remaining static, and still others deteriorating over time. Plus some new detrimental soil conditions are likely to occur from the above listed ongoing activities.

In the following discussion, the degree of impact of compaction, puddling, displacement, severe burning, erosion, mass wasting, organic matter loss and drainage class change is severe enough to classify effects as DSCs. Extent is described generally as affected area and duration is noted as years. The effects outlined below are based on soil mitigation measures being implemented in full.

Ongoing activities effects on soil quality would include:

> Compaction and Puddling: These soil impacts are associated with skid trails, landings and non-surfaced roads, ATV trails, livestock trails and dispersed campsites. Effects include reduced water holding capacity, infiltration and permeability, reduced ability of soil to support vegetation and organisms in and on the soil, increased runoff and in extreme cases, a change in drainage class.
>
> Reoccurring uses by wildlife, ATVs, vehicles and equipment could potentially re-compact or re-puddle these areas. Where recurring impacts are low to non-existent, existing compaction, and puddling would improve over time in the top 4 inches, due to beneficial effects of frost heaving, root establishment of vegetation, and rodent activity. Compaction deeper than 4 inches could persist 20 to potentially 100+ years.
>
> Displacement: These soil impacts are associated with system roads, previously use landings, skid trails and rock-pits. Effects include reduced water holding capacity, loss of ground cover, nutrients and soil microorganisms and increased runoff due to an increased amount and condition of bare ground exposed. Duration of effects is permanent, unless soils are replaced with equipment, however some soil mixing will still occur.

Severe Burning & Organic Matter Loss: These soil impacts are associated with areas with soil displacement, discussed above, plus areas that experience prescribed fire and wildfire. Effects include short-term to long-term loss of organic ground cover (duff, litter, coarse wood, basal area of herbaceous plants) and canopy cover (herbaceous plants, shrubs, trees). Severely burned soils experience nutrient loss, microorganism mortality, increased water repellency, runoff and erosion hazard.

Organic matter would continue to accumulate and recycle in rangeland and forestland plant communities. Organic matter accumulations would be slowest in rangelands and in forestlands where the canopy has been removed. In areas where the canopy cover is present, organic matter accumulations on the forest floor would equal or exceed historic accumulation rates due to current fire control activities, which would continue to maintain or improve soil productivity. Existing disturbed areas such as skid trails, landings, and decommissioned roads would continue to have lower than normal accumulations of organic matter on the soil surface. Moderate to severe burn effects would decrease as trees, herbaceous plants, and soil flora and fauna re-colonize burned sites and organic matter accumulates.

The potential for high intensity wildfires increases every year in the absence of forest density management and surface soil organic matter management. In the event of a wildfire, the potential effects upon soil productivity, extent of post-fire soil erosion, and the length of time needed for soil recovery from those impacts would depend primarily upon the fire intensity, mosaic, and fire size. The length of time needed for soil recovery would depend upon residual post-fire surface soil organic matter, soil erosion, and the length of time needed for ground cover reestablishment. Stand replacing wildfires could reduce long-term soil productivity by removing litter, humus, and large downed woody material from the soil surface, by consuming soil organic matter, and by killing soil flora and fauna essential to the nutrient recycling process to a 9 to 16 cm soil depth. Surface soils and their associated nutrient reserves could also be lost through increased erosion due to loss of ground cover and due to soil crusting and water repellency, which reduces infiltration.

Drainage Class (Soil Moisture Regime): Changes in soil drainage class exist where rock-pits store water, where water collects in puddles on native surface roads, and where road fills have covered riparian wetlands. No change in soil drainage class is expected over time under this alternative.

Alternatives 2, 3, 4 and 5

Ground Based Treatment (HFU, HTH, HIM, HPO, HSH, HSA, Grapple Pile, Mastication, Biomass Removal)

The most important direct effects of treatment activities on soils are compaction and displacement of litter, duff and topsoil by mechanical equipment. Most of these effects would be in ground based yarding units with reduced effects in the units where mastication or grapple piling is proposed. Post-project unit DSCs for all action alternatives range from 0 to 20% with an average of 9% in Alternative 5(due to the additional mechanical acres treated and biomass removal), 8% in Alternative 2, 6% in Alternative 3, and 5% in Alternatives 4 (due to the predominance of non-commercial/non-mechanical fuel reduction treatments). Four units (83, 115, 123, and 128) totaling approximately 160 acres have the highest potential post-project DSCs (18.4-20%). Unit 83 is primarily because it is only an acre in size and has an existing road immediately adjacent to it DSCs within the unit are only at 1%. Units 115 (29 acres) has a similar situation with DSC's within the unit at 1% and a DSC of 9.4% from the adjacent road. Although DSCs within these units are currently very low, both units would require forwarder systems and subsoiling of all skid trails and landings post-project to mitigate potential soil compaction and detrimental soil conditions. While Alternative 3 only treats unit 115 of the four units, Alternatives 2 and 5 treats all four and Alternative 4 treats units 123, 115, and 128; however, unit 115 is non-commercial (pre-commercial thinning) and would not increase DSCs above existing. Therefore, due to implementation of design criteria and mitigation measures, expected new DSC's for all treatment units would meet LRMP standards and not be more than 20%, they would be lowest in Alternatives 3 and 4 and higher in Alternatives 5 and 2.

Appendix C describes the pre and post-harvest treatment percent DSC's by unit for the project.

Erosion Hazard: There are up to 99 mechanical treatment units dominated by soils that are severe or very severe for erosion potential. Erosion hazard is determined in the absence of live vegetation. Surface erosion potential due to overland flow is mitigated primarily by rooted vegetation and duff layers on the soil surface. With the exception of bare areas where rain splash erosion may occur, material left on site following mastication or grapple piling will reduce the potential for loss of soil from any treated unit.

Displacement: All units where mechanical treatment is used for vegetative manipulation have the potential for soil displacement.

Units where forwarder based harvest is used will have lower displacement due to the full suspension of the material removed and the use of slash as a surface cover. Units where partial suspension removal is used will result in higher levels of displacement due to logs dragging on the ground surface.

Grapple piling units are at the highest risk for displacement due to the repetitive turning made by track mounted equipment. Retention of higher levels of coarse woody material (CWM) will reduce the number of "grabs" made during grapple piling, or maneuvering required by arm mounted masticators thereby reducing the potential for soil displacement.

Compaction Potential: There are up to 143 mechanical treatment units are dominated by soils with high compaction potential. Ten percent of these units will be reviewed by the district watershed/soils specialist and TSA following treatment to determine if additional mitigations are required to meet objectives.

The use of low ground pressure machines and covering of trails with slash mats such as those generated with cut to length systems can limit the consequences of one or two passes of equipment, but do not appear to be effective in minimizing soil compaction when equipment must use trails multiple times (Froese 2004, Han 2005). Where multiple passes are used, soil will show higher compaction, but compaction should be limited to the ruts of well-defined trails.

Standard mitigations for all units include the following methods to reduce the accumulation of new DSC's:

- Limit season of operation to soils with high compaction potential. Operate machinery on dry soils with less than 20% moisture or in winter conditions with four inches of frost (Flatten 2002) or 24 inches of snow
- Use of well placed, existing skid trails, if available, to reduce additional DSC's (reduced by 5%)
- Scattering of organic matter over skid trails and landings to provide a minimum of 50% effective ground cover and seeding with native seed to facilitate vegetation recovery

Additional mitigations if skid trails or landings are detrimentally impacted:

- Subsoiling skid trails and/or whole tree landing areas (if created) to reduce final DSC's
- Water bar construction where detrimental soil displacement is evident

Since it is unknown what exactly level of DSC's will be accumulated in each unit, all units where high compaction potential due to ash dominated soils are found will require subsoiling of multiple pass return trails following harvest unless cut to length removal methods are utilized. If post-harvest inspection determines that soil compaction and displacement is minimal due to increased skid trail spacing, use of low displacement removal techniques (cut to length) and harvest during dry/frozen soil periods, subsoiling may not be required.

The use of experienced equipment operators who minimize track disturbance to the soil during equipment maneuvering when completing grapple piling or mastication have been shown to reduce accumulation of additional DSC's. Increasing the level of CWM on units with high compaction potential, will reduce multiple passes with grapple or mastication machinery, reducing potential for accumulation of additional DSC's.

Long term soil productivity of forested ecosystems relies on a continual flux of coarse woody material. Important nutrients to the soil ecosystem, such as sulfur, phosphorus and nitrogen, are supplied by decaying coarse woody material (Graham 1994). Timber harvest, slash disposal and site preparation can reduce the amount of organic material in the forest floor to below what is needed to ensure soil productivity (Harvey et al. 1987). Recent publications have provided information on appropriate levels of coarse wood required to protect long term soil productivity (Agee 1994, Harvey et al. 1994, Graham 1994).

One indirect effect of harvest activities on soils would be the loss of nutrients by removing trees from the ecosystem that would naturally recycle into the soil over the long-term if they were left on site. Prescriptions used for this project will leave adequate residual large and small trees on each unit to replenish this initial loss of stems. Much of the residual woody material will be left on site in the way of tops and roots which will decompose naturally, maintaining soil productivity.

Another effect is increased soil erosion hazard in areas where ground cover is removed by equipment over a large enough area to pose a hazard of long-term accelerated erosion. Vegetation protects the soil surface from raindrop impact, dissipates the energy of overland flow, and binds soil particle together. Soils on steep slopes with poor vegetative cover and lack of structural development are more susceptible to erosion than soils present on flatter terrain. Treatment units are not generally placed within areas where this condition is present.

Given alternative 5 includes more acres of ground based harvest, effects on the soils and effects to soil quality would be slightly greater than alternative 2, 3 and 4 **(table 6). A**lternative 4 would have the lowest potential for effect. Under each action alternative, the probable extent of detrimental soil disturbance would be kept under the Forest Plan's standard of 20% in treatment activity areas through the application of BMP's and site specific project design requirements.

Prescribed Fire

In general, the estimated percent additional detrimental soil conditions that maybe be expected from prescribed fire range from 1-2% of the actual area burned. Prescribed fire usually results in a mosaic of low, moderate and high fire severity that would be classified mostly as low severity burn class. Low-severity burn class effects include up to 2% high fire severity, up to 15% moderate fire severity, and at least 83% low fire severity and unburned. There is potential for fall burns and for heavier fuel areas to experience the low end of the moderate-severity burn class.

High fire severity effects are what Region 6 standards define as a detrimental soil condition (FSM 2520). The top of the mineral soil would be reddish to orange. Soil organisms would be killed to a depth of 9 to 16 cm. All organic materials in color-altered soil near the soil surface, plus all litter and humus and most woody debris on the soil surface would be consumed. There would be up to about 1% high fire severity from spring burns and about 2-3% from fall burns.

For moderate severity fire areas, soil organisms would be killed to a depth of 3 to 5 cm. Litter would be consumed and duff would be charred to consumption. Approximately 2-15% of the area would experience moderate fire severity, ranging from 2-5% for spring burns and higher, up to 15%, for fall burns.

For low severity fire areas, soil organisms would be killed to a depth of only 1 cm, and duff would be largely intact with scorching to consumption of litter.

Erosion hazard would increase in moderate and high fire severity areas due to loss of litter and duff on the soil surface. However, change in erosion hazard would be small in low-severity burn class (and low end of moderate-severity burn class) areas where a minimum of 60-70 percent total effective ground cover still exists, there is a good mosaic burn pattern, and a residual forest canopy has the potential to replace litter burned by the fire.

Roads

The primary direct effect of road work on soil quality is detrimental soil displacement, loss of soil productivity and compaction. There is no new specified road construction proposed for this project. Existing roads will be utilized. Temporary roads will be required for alternatives 2, 4 and 5. Temporary roads will be placed on existing user roads where appropriate, reducing the level of disturbance. Temporary roads will be decommissioned following use by filling any cuts, slash placement and seeding with native grasses and forbs.

The primary indirect effect of road work on soil quality is soil erosion. Some soil erosion could occur following use of previously closed roads for administrative and firewood removal uses. Maintenance of roads following industrial use and prohibiting used during periods of high soil moisture or rainfall events will reduce this effect.

Any maintenance required to facilitate use of the existing road system will be done within the existing road prism and will be completed to typical standards for the type of road to be maintained. **Table 4** summarizes the miles of road work that would occur under each alternative in the East Face Project.

Table 4. Miles of Road Work Proposed for Alternatives

Road Work	Alternatives				
	1	2	3	4	5
Closed Roads opened for administrative access (miles)	0.0	107	66.9	38.6	122.7
Roads Reconstructed (miles)	0.0	53	39.3	27.8	61.6
Temporary Roads constructed (miles)	0.0	12.6 (6.0 on existing 2 track) (6.6 new construction)	0.0	2.6 (0.67 on existing 2 track) (1.95 new construction)	14.7 (6.57 on existing 2 track) 8.14 new construction)

For Alternatives 2-5, closed roads reopened would not measurably increase soil displacement as the displacement and mixing has already occurred. Placement of road closure barriers would not cause new soil disturbance outside of the existing roadway. DSC's are included in the total existing condition percentage.

Roads reconstructed will follow standard forest BMPs. Temporary roads would be decommissioned following standard BMPs at the conclusion of their use period. Accumulated DSC's due to soil mixing would occur and however the expected duration of the DSC's would be limited following recolonization of the site with native grasses and other vegetation. Alternative 3 would have no direct or indirect effect of temporary roads on soil resources.

Mechanical Fireline Construction

The primary direct effect of mechanical fireline construction on soil quality and productivity is similar to roads in that some displacement and compaction would occur where the fireline is constructed. Mechanical fireline is by design much less disruptive to the soil profile than road construction.

The primary indirect effect of mechanical fireline construction on soil quality would be erosion. Erosion would occur if firelines are not properly waterbarred following construction or are allowed to remain in place for a full season following construction. Mechanical fireline is rehabilitated following use to prevent erosive channeling of surface runoff.

Cumulative Effects on Soils

Potential cumulative effects are analyzed by considering the proposed activities in the context of past, present and reasonably foreseeable actions. These are the areas where cumulative effects have occurred or may occur. In addition, some activities have an influence that may extend downstream in the subwatershed within the project area boundary. This broad area is referred to as the "cumulative effects analysis area" and in general all alternatives are considered in the context of relevant past, present and reasonably foreseeable activities in this area. Activities which occurred in the past have been incorporated into the existing condition of the project area. A summary table of the present and reasonably foreseeable future management activities in the cumulative effects analysis area is located in **Appendix D** of the analysis and has been used to assess the cumulative effects of implementing this project on rangeland resources.

ALTERNATIVE 1- No Action

The only present or reasonably foreseeable future action which would overlap in time and space within this project area which may have a potential to have a short term increase in DSCs would be OHV use and livestock grazing. Livestock grazing within the boundaries of the Lobo allotment would continue; however, standards and guidelines for management of livestock use would continue to be implemented minimizing the potential for a measurable increase in area DSCs.

Use of OHVs/snowmobiles in the project area should not measurably increase under Alternative 1 and motor vehicle use off designated roads, trails, and areas would be managed by the forest travel management plan once that is completed which should reduce soil disturbance by motor vehicles.

Alternatives 2, 3, 4 and 5

Implementation of any of the action alternatives would not increase DSCs within any treatment unit beyond the 20% LRMP threshold. The proposed action also includes mitigations that would decrease the potential for accumulating additional DSCs. It is important to keep in mind that DSCs naturally change over time. Certain DSCs recover in a few years to decades, while other DSCs require recovery times of 100 or more years without restoration treatments. DSCs with long recovery rates are often considered for restoration treatments, where environmentally and economically feasible.

As firewood becomes more difficult to find, firewood gatherers are building firewood roads to get farther to new wood sources. Opening roads for use in East Face has the potential to could increase these user built roads into new areas not previously disturbed. Motor vehicle use off designated roads, trails, and areas would be managed by the forest travel management plan once that is completed which should reduce soil disturbance by motor vehicles and allow current user built roads and trails to recover and revegetate reducing DSCs within the area.

Summary of Effects

The planned actions for all action alternatives adhere to R6 soil quality guidelines for maintaining soil productivity provided that project design features are implemented. The meet R6 soil quality standards, each project unit must have less than 20 percent of its area in detrimental soil conditions or the cumulative effects from project implementation and rehabilitation should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality (R6 Supplement 2500-981). If this threshold for change is reached, corrective actions are taken to restore or stabilize the impacted sites and move the unit towards a net improvement in soil quality.

The East Face project actions are not expected to create detrimental soil conditions in excess of 20% in any activity unit. This determination is consistent with Forest-wide standards for site productivity (USDA 1986). The project would also comply with R6 erosion standards following activities. Implementation of project design features and implementation of project mitigations to reduce and control detrimental soil disturbance can minimize impacts ensuring that these standards are met following project implementation.

Alternative 1 will add no new direct or indirect effects and will create no net increase in detrimental soil condition due to mechanical removal or fuels treatment. The risk of loss of soil quality due to catastrophic wildfire would increase over time with Alternative 1 due to maintaining the current level of fuel loading.

Alternative 2 and 5 treat the most acres with commercial mechanical removal and would accrue the most new DSC's with Alternative 5 creating the most new DSC's. Non-commercial mechanical treatment would be similar for all action alternatives. These alternatives also require the most miles of temporary road to be constructed. Alternative 5 poses the greatest risk to maintain soil quality due to the increased mechanical treatment acreage associated with biomass removal from the non-commercial units.

Table 5. Treatment comparison for East Face project by acre.

Treatment Type	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Total Commercial Mechanical Acres	6,722	3,879	2,844	10,221 (includes 2,560 acres biomass removal)
Total Non-Commercial Mechanical Acres	1,745	1,745	1,700	1,745
Total Post treatment Mechanical Acres	10,704	6,842	8,568	8,083
Total Biomass Removal Acres	0	0	0	2,560
Total Prescribed Fire Acres	6,685	6,043	6,643	6,685
Total Temporary Road Miles	12.6	0.0	2.6	14.7

All alternatives treat the most acres within LTA 116 and LTA 156 (table 6). These LTA's exhibit the highest potential likelihood for soil compaction and displacement due to the high percentage of ash within the soil profile (see existing condition narrative for LTA descriptions). These are the most sensitive but also the most productive soils within the project area.

Table 6. Mechanical treatment comparison for East Face project by LTA.

LTA	Alternative 2	Alternative 3	Alternative 4	Alternative 5
116	3,474	2,515	1,562	4,144
117	273	169	166	486
126	272	189	74	272

LTA	Alternative 2	Alternative 3	Alternative 4	Alternative 5
131	535	280	483	625
132	64	32	64	64
156	2,042	1,328	918	3,220
157	957	485	739	1,600
167	466	275	170	1,130
231	20	20	0	44
TOTAL	**8,103**	**5,293**	**4,176**	**11,585**

Consistency with Laws and Policy

All action alternatives will meet Forest Plan and Regional soil standards designed to maintain long-term soil productivity.

Irreversible and Irretrievable Commitments

The action alternatives are not expected to create any impacts that would cause irreversible damage to soil productivity. Timber harvest or vegetative treatment would avoid landslide prone areas, existing debris slides/debris torrents, and other potentially unstable lands on steep slopes. Careful planning, project design requirements and Best Management Practices would be used to prevent irreversible losses of the soil resource.

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